

Claims

What is claimed is:

1. An expandable fastener assembly for insertion into a substrate, comprising:
 - (a) a threaded fastener having a proximal end and a distal end, the proximal end being provided with a head having turning means, the fastener having a shank extending from the head to the distal end along a longitudinal axis, the shank being provided with double interleaved helical threads extending radially outwardly from the shank, each of said threads having a first surface generally facing the distal end or a second surface generally facing the proximal end, or both and each double interleaved helical thread pair being either proximal or distal; and
 - (b) a continuous, expandable helical coil member wound around the shank of the threaded fastener, between each of the double interleaved helical thread pairs, the coil member having a radially inwardly facing portion and a radially outwardly facing portion with a thread-contacting surface extending between the inwardly and outwardly facing portions and generally facing the distal end of the fastener or may in other embodiments be generally facing the proximal end of the fastener, wherein, prior to insertion of the fastener assembly into the substrate, the coil member is in a radially compressed form; and
 - (c) releasable securing means by which the coil member is releasably secured in its radially compressed form, along at least a portion of its length, to the shank of the fastener, wherein the releasable securing means maintains connection between the coil member and the fastener, thereby maintaining the coil member in its radially compressed form at least until that part of the fastener assembly that is so compressed is completely or substantially completely threaded into the substrate.
2. The fastener assembly of claim 1, wherein the coil member is permanently connected to the shank of the fastener at the distal end, thereof.
3. The fastener assembly of claim 1, wherein the releasable securing means is selected from the group comprising adhesives, welds or mechanical connections between the coil member and the fastener.

4. The fastener assembly of claim 1, wherein radial expansion of the coil member causes radial biasing of the radially outwardly facing portion of the coil member against the substrate, while the radially inwardly facing portion remains meshed with the double interleaved helical thread pairs of the fastener.
5. The fastener assembly of claim 1, wherein the thread-contacting surface of the coil member comprises a radially inward portion and a radially outward portion with a pivot axis there between, the releasable securing means releasably connecting the radially outward portion of the thread-contacting surface to the second surface of the thread along at least a portion of the coil member, the pivot axis being tangential to the coil member.
6. The fastener assembly of claim 5, wherein the twisting of the coil member about the pivot axis causes rotation of the radially outward portion of the thread-contacting surface away from the second surface of the thread, overcoming the connection provided by the releasable securing means.
7. The fastener assembly of claim 5 wherein the twisting of the coil member about the pivot axis causes the shank-contacting surface of the coil to be pushed up an inclined plane 21a, overcoming or assisting in overcoming the proximal connection provided by the releasable securing means.
8. The fastener assembly of claim 5, wherein said twisting of the coil member results in the radially outward portion of the thread-contacting surface being axially displaced toward the distal end of the fastener, thereby engaging the second surface of the thread and biasing the fastener into the substrate and the fastener assembly of claim 5, wherein in some embodiments, said twisting of the coil member results in the radially outward portion of the tread-contacting surface being axially displaced toward the proximal end of the fastener, thereby engaging the first surface of the thread and biasing the fastener out of the substrate.
9. The fastener assembly of claim 8, wherein the twisting of the coil member is produced during tightening of the fastener in the substrate, whereby tightening draws the fastener axially in the direction of the proximal end, causing the thread to push against the coil member such that a surface of the coil member opposite the thread-contacting surface and radially outwardly of the pivot axis engages the substrate and causes pivoting of the coil member about the pivot axis.

10. The fastener assembly of claim 8, wherein the twisting of the coil member is produced during the winding of the helical coil member, into its radially compressed form, by rotating the said coil member that is tilted about its pivot axis such that the tilt is reversed, and then the said coil member is constrained so as to preserve the said radial compression and the said reverse tilt, thereby latching the tilt, and when the said constraints are removed, thereby unlatching the tilt, in addition to radial expansion of the coil member, the surface of the coil member opposite the thread-contacting surface and radially outward of the pivot axis engages the substrate and pushes the threaded member into the said substrate.
11. The fastener assembly of claim 8, wherein the twisting of the coil member is produced during the winding of the helical coil member, into its radially compressed form, by rotating the said coil member that is tilted about its pivot axis such that the tilt is decreased, and then the said coil member is constrained so as to preserve the said radial compression and the said decreased tilt, and when the said constraints are removed, in addition to radial expansion of the coil member, the surface of the coil member opposite the thread-contacting surface and radially outward of the pivot axis engages the substrate and pushes the threaded member into the said substrate.
12. The fastener assembly of claim 8 wherein said twisting of the coil member caused by tightening the fastener results in the coil member exerting an axially directed biasing force against the second surface of the thread in a direction toward the distal end of the fastener.
13. The fastener assembly of claim 8, wherein the radially outwardly facing portion of the coil member extends radially outward of the thread when the coil member is in its radially compressed form.
14. The fastener assembly of claim 1, wherein a space 21 may be included between said double interleaved helical threads, sufficiently large to allow the surface of the thread member opposite the thread-contacting surface to move in a direction parallel to the longitudinal axis of the threaded member, facilitating the breaking of any connection between the coil element and the thread and/or facilitating the latching and unlatching of the coil.

15. The fastener assembly of claim 1, wherein ratcheting elements are included on the surfaces of the coil member and/or the double interleaved helical threads, that act as to allow expansion of the coil into the substrate radially away from the threaded member, but discourage reversal of said expansion, once it has occurred at any point along the fastening system.
16. The fastener assembly of claim 3, wherein the securing means is an adhesive, which is water-soluble, soluble to some other solute or biodegradable.
17. The fastener assembly of claim 8, wherein the coil member is comprised of a shape memory alloy in which a martensitic state of the alloy corresponds to the radially compressed form of the coil member and the austenitic state of the alloy corresponds to the radially expanded form of the coil, and wherein said shape memory alloy is transformed from the martensitic state to the austenitic state after the fastener is inserted into the substrate.
18. The fastener assembly of claim 15, wherein the coil member has a hollow tubular cross-section or a corrugated cross-sectional shape which is deformed when the fastener is tightened, and which shape is recovered when the shape memory alloy is transformed from the martensitic to the austenitic state.
19. The fastener assembly of claim 1, wherein one of the surfaces of the first surface of the proximal thread is curved permitting the coil to rotate as it expands away from the fastening member, thereby pushing the fastening assembly into the substrate.
20. The fastener assembly of claim 1, wherein the second surface of the proximal thread and the first surface of the distal thread both make contact with the coil member such that the coil member does not roll-over the distal thread when the coil member expands away from the shank of the fastening member and the fastening member is tightened into the substrate or both.
21. The fastener assembly of claim 1, wherein the coil member comprises two interleaving coils, a first coil of which engages the first surface of the thread, and a second coil of which engages the second surface of the coil.

22. The fastener assembly of claim 1, wherein the coil member and or the threads are coated with material such as Teflon™ that will improve the relative movement of the said coil and threads when the coil is unloaded at any point.
23. The fastener assembly in claim 1, wherein the coil member separates from the fastener at points of detachable-attachment, by the operator turning the screw into the substrate or interrupting the turning-in of the fastener, with a counter rotating or turning out of the fastener, and

such turning-in and/or turning-out of the fastening member causes a curved or shaped portion of the coil member to differentially contact the substrate as compared to the remaining portion of the said coil member, and

such differential contact causes the said coil member to twist at or around the point of detachable-attachment,

and such twisting causes the detachable-attachment to detach.

24. A fastener assembly for insertion into a substrate, comprising:

(a) a threaded fastener having a proximal end and a distal end, the proximal end being provided with a head having turning means, the fastener having a shank extending from the head to the distal end along a longitudinal axis, the shank being provided with double interleaved helical threads extending radially outwardly from the shank, said threads having a first surface generally facing the distal end or a second surface generally facing the proximal end, or both, and each double interleaved helical thread pair being either proximal or distal.

(b) a continuous helical coil member wound around the shank of the threaded fastener, the coil member having a radially inwardly facing portion and a radially outwardly facing portion with a thread contacting surface extending between the inwardly and outwardly facing portions and generally facing the distal end of the fastener or may in other embodiments be generally facing the proximal end of the fastener, wherein, prior to insertion of the fastener assembly into the substrate, the coil member is in a radially compressed form; and

wherein the thread-contacting surface of the coil member comprises a radially inward portion and a radially outward portion with a pivot axis there between, the radially outward portion of the thread-contacting surface engaging the second surface of the distal thread pair prior to insertion of the fastener into the substrate, wherein tightening of the fastener in the substrate causes twisting of the coil member about the pivot axis so as to cause rotation of the radially inward portion of the coil toward the second surface of the thread, and said twisting of the coil member in combination with the complementary shapes of the first surface of the said coil member and the second surface of the said thread member, cause the coil member to move proximal to the equilibrium point and thereby unlatch, and the radial inward portion of the coil then contacting the radially inward surface of the second surface of the distal thread and the radially outward surface of the first surface of the coil moving away from the radially outward portion of the thread, that surface being axially displaced toward the distal end of the fastener, thereby biasing the fastener into the substrate.
